REMARKS

In the last Office Action, the Examiner rejected claims 1-3 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,617,833 to Xi. Additional art was cited of interest.

In accordance with the present response, the specification has been suitably revised to correct informalities, provide antecedent basis for the claim language, and bring it into better conformance with U.S. practice. Original independent claim 1 has been amended to incorporate the subject matter of claim 2, which has been canceled. Original claims 1 and 3 have also been amended in formal respects to improve the wording and bring them into better conformance with U.S. practice. New claims 4-9 have been added to provide a fuller scope of coverage. A new abstract which more clearly reflects the invention to which the amended and new claims are directed has been substituted for the original abstract.

Applicant requests reconsideration of his application in light of the foregoing amendments and the following discussion.

Brief Summary of Invention

The present invention is directed to a voltage regulator and to an electronic device equipped with the voltage regulator.

Figs. 3 and 4 show a conventional voltage regulator having an error amplifier 13. An operating current of the error amplifier 13 is determined by a constant current circuit 20. Thus, if a current flowing into the constant current circuit 20 is reduced in order to realize a voltage regulator having low current consumption, when the power source is started, or when a load connected with an output terminal 6 of the voltage regulator is suddenly reduced, the output voltage largely tends to exhibit and overshoot characteristic. Stated otherwise, a power source start characteristic is sacrificed. On the other hand, if a current flowing into the constant current circuit 20 is increased in order to realize a voltage regulator having an improved overshoot characteristic, the low current consumption characteristic is sacrificed.

When a battery is used as the power source, a low current consumption characteristic is required in order to increase the life of the battery. On the other hand, with regard to the overshoot characteristic of the output voltage of the voltage regulator, it is necessary to avoid a state in which the output voltage becomes equal to or larger than a

withstanding voltage of an external element connected with the output terminal of the voltage regulator. When the overshoot characteristic voltage regulator is improved, for the purpose of achieving a wide band of the error amplifier, it is basically unavoidable to increase the operating current of the error amplifier. However, when a battery is used as the power source, it is essential to obtain a low current consumption characteristic.

The present invention overcomes the drawbacks of the conventional art by providing a voltage regulator having an improved overshoot characteristic and a low current consumption as compared to the conventional art.

Figs. 1-2 show a voltage regulator according to the present invention embodied in the claims. The voltage regulator has a reference voltage circuit 10, a voltage source 15, an output terminal 6 from which an output voltage Vout is outputted in accordance with a voltage VDD1 of the voltage source 15, and a voltage dividing circuit 11, 12 for dividing the output voltage Vout of the output terminal 6. An error amplifier 16-20 outputs a signal in accordance with an output Va of the voltage dividing circuit 11, 12 and an output Vref 1 of the reference voltage circuit 10. An output transistor is connected between the voltage source 6 and the voltage dividing circuit 11, 12 and is ON/OFF-controlled in accordance with the signal outputted from the error amplifier 16-20.

According to the present invention, a current adding circuit 21 controls an operating current of the error amplifier 16-20 in accordance with the output voltage Vout of the output terminal 6 and the voltage VDD1 of the voltage source 15 by increasing the operating current of the error amplifiers 16-20 when the output voltage Vout of the output terminal 6 is higher than a predetermined value. More specifically, the operating current of the error amplifiers 16-20 is controlled to a temporarily large value only in a case when the output voltage Vout of the output terminal 6 is higher than a predetermined value. In cases other than when the output voltage Vout of the output terminal 6 is higher than the predetermined value, the operating current of the error amplifier 16-20 is controlled to a small value in order to achieve a reduction in power consumption of the voltage regulator.

By the foregoing construction and corresponding functions, an overshoot characteristic of the voltage regulator is substantially improved, and a power consumption of the voltage regulator is substantially reduced. These advantageous features are achieved by providing a voltage regulator in which only in the case where the voltage to which the output voltage is to be controlled is higher than the preselected value, the operating current of the error

amplifier of the voltage regulator is controlled to a temporarily large value to achieve a wide band of the error amplifier, thereby improving the overshoot characteristic of the voltage regulator. In cases other than the above-mentioned case, the operating current of the error amplifier is controlled to a small value in order to achieve a reduction in current consumption.

Traversal of Prior Art Rejection

Claims 1 and 3 were rejected under 35 U.S.C. §102(e) as being anticipated by Xi. Applicant respectfully traverses this rejection and submits that amended claims 1 and 3 recite subject matter which is not identically disclosed or described in Xi.

Amended independent claim 1 is directed to a voltage regulator and requires a reference voltage circuit, a voltage source, an output terminal from which an output voltage is outputted in accordance with a voltage of the voltage source, a voltage dividing circuit for dividing the output voltage of the output terminal, an error amplifier for outputting a signal in accordance with an output of the voltage dividing circuit and an output of the reference voltage circuit, an output transistor connected between the voltage source and the voltage dividing circuit and ON/OFF-controlled in accordance with the signal outputted from the error amplifier, and a

current adding circuit for controlling an operating current of the error amplifier in accordance with the output voltage of the output terminal and the voltage of the voltage source by increasing the operating current of the error amplifier when the output voltage of the output terminal is higher than a predetermined value. No corresponding structural and functional combination is disclosed or described by Xi.

Xi discloses a voltage regulator responsive to a reference voltage at an input port to provide a regulator voltage at an output port. The voltage regulator includes a circuit including a delay capacitor C_D connected between the gate of a transistor MN3 and the ground, and a current sink 14 that sinks current I_D connected between one contact of a single pole double throw switch S_1 (Fig. 2).

The Examiner contends that Xi discloses a current adding circuit for controlling an operating current of an error amplifier circuit (MP1, MP2, MN1, MN2, MN3, MN4) in accordance with an output voltage of an output terminal and a voltage of a voltage source by increasing an operating current of the error amplifier when the output voltage is higher than a predetermined value. Applicant respectfully disagrees with the Examiner's contention.

As disclosed in column 4, lines 19-28 of Xi, during transition from a disabled mode to an enabled mode, the switch S_1 is switched to the current sink 14 sinking I_D, which allows the current sink 14 to discharge capacitor C_D at a rate determined by the magnitude of I_D and by the capacitance of the capacitor C_D. Until capacitor C_D is sufficiently discharged, the turn-ON of transistors MN1, MN2 is prevented. Thus, upon receipt of an enable signal, the turn-ON of MN2 is delayed by an amount determined by the designer in selecting I_D and C_D.

Thus, the function of the switch S_1, current sink 14 and delay capacitor C_D in Xi is to prevent the transistors MN1 and MN2 from turning ON until the capacitor C_D is sufficiently discharged. In contrast, amended independent claim 2 requires a current adding circuit for controlling an operating current of the error amplifier in accordance with the output voltage of the output terminal and the voltage of the voltage source by increasing the operating current of the error amplifier when the output voltage of the output terminal is higher than a predetermined value. This structure and corresponding function of the current adding circuit recited in amended independent claim 1 is not disclosed or described by Xi.

In the absence of the foregoing disclosure recited in amended independent claim 1, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration"); Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under § 102 can not be found"); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Xi for the reasons stated above. Furthermore, Xi does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Xi's voltage regulator to arrive at the claimed invention.

Claim 3 depends on and contains all of the limitations of amended independent claim 1 and, therefore, distinguishes from Xi at least in the same manner as claim 1.

In view of the foregoing, applicant respectfully requests that the rejection of claims 1 and 3 under 35 U.S.C. §102(e) as being anticipated by Xi be withdrawn.

Applicant respectfully submits that new claims 4-10 also patentably distinguish from the prior art of record.

Claims 4-5 depend on and contain all of the limitations of amended independent claim 1 and, therefore, distinguish from the prior art of record at least in the same manner as claim 1.

New independent claim 6 is directed to a voltage regulator and requires a reference voltage circuit, a voltage source, an output terminal from which an output voltage is outputted in accordance with a voltage of the voltage source, a voltage dividing circuit for dividing the output voltage of the output terminal, an error amplifier for outputting a signal in accordance with an output of the voltage dividing circuit and an output of the reference voltage circuit, and control means for controlling an operating current of the error amplifier to a temporary large value only in a case when the output voltage of the output terminal is higher than a predetermined value. No corresponding structural combination

is disclosed or suggested by the prior art of record. For example, Xi does not disclose or suggest control means for controlling an operating current of an error amplifier to a temporary large value only in a case when the output voltage of the output terminal is higher than a predetermined value. As noted above with respect to amended independent claim 1, the function of the switch S_1, current sink 14 and delay capacitor C_D disclosed by Xi is to prevent turning ON transistors MN1 and MN2, not to control an operating current of the error amplifier to a temporary large value only in the case when the output voltage of the output terminal is higher than a predetermined value, as recited in independent claim 6.

New claims 7-9 depend on and contain all of the limitations of independent claim 6 and, therefore, distinguish from the prior art of record at least in the same manner as claim 6.

In view of the foregoing, applicant respectfully submits that the application is in condition for allowance. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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NOVEMBER 10, 2005
Date